the stapedius muscle in place and comparison to the condition where both muscles are cut.

Tensor tympani and the stapedius muscle are compared with regard to the amount of contralateral suppression produced, the DP frequency range over which they are active, the onset and offset characteristics of suppression, latency and phase shift. Preliminary data point to tensor tympani function that is significantly greater than that previously attributed to it in the rat.

767 A detailed analysis of the effects of primary levels on DPOAE components

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Recent modeling and experimental efforts have established the presence of two spatially and mechanistically distinct sources of distortion product otoacoustic emissions (DPOAEs) in humans (e.g. Talmadge et al., 1997,1998,1999; Shera & Guinan, 1999; Knight & Kemp 1999,2000,2001; Konrad-Martin et al., 2001, Kalluri & Shera 2001). As a result, research is now focused on the specific characteristics of the two sources. Preliminary results that have already been published show that both primary level and frequency ratio play significant roles in determining the absolute and relative contributions from the two sources to the signal recorded in the ear canal (e.g., Knight & Kemp, 2000, 2001, Konrad-Martin et al., 2001). Most studies to date have used either suppression or inverse-FFT methods to separate the components of DPOAEs.

In this paper we present a detailed analysis of the role of primary levels in determining the contribution from the different sources. Data recorded with a wide range of primary levels and several primary frequency ratios will be presented. The two primary components are obtained using an inverse-FFT paradigm. The data is evaluated in the framework of the two-source interference model (Talmadge et al., 1997,1998,1999).

768 Mechanisms of OAE Production in Humans

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It is evident that there are two distinct sources of DPOAE in humans (Heitmann et al., 1997; Brown et al., 1996; Brown & Gaskill, 1996), with a theoretical framework arguing also for two distinct mechanisms of OAE production i.e., i: a retrograde traveling wave produced by the amplifier induced pressure gradient across the basilar membrane, and ii: linear coherent reflections (encompassing intra-cochlear standing waves) that are level-dependent, being less significant at high stimulus levels (Zweig & Shera, 1995; Talmadge et al., 1998, 1999; Shera & Guinan, 1999). Available evidence argues for two distinct mechanisms (Shera & Guinan, 1999), with DPOAE fine structure being explained by the rapid phase rotation of the CF place component relative to the component arising from the f2 region. The level-dependency of the mechanism of production of the CF place component has not been examined to date, and the extent of published data on DPOAE fine structure is limited. Here we present DPOAE fine structure data at a number of stimulus levels (L2 = 30 to 70dB SPL), suppressed and unsuppressed, examining whether the mechanism of production of the CF place component is level-dependent and whether there can be a shift in mechanism of production of the CF place component that is place-dependent.

769 Using DPOAEs to Measure Forward and Reverse Middle-Ear Transmission Noninvasively

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The interpretations of physiological and psychophysical measurements of hearing are often confounded by incomplete knowledge of the transmission characteristics of the middle ear. Although middle-ear transfer functions have been measured invasively in human cadavers and in laboratory animals, the substantial variability among ears from the same species limits the power of mean data to predict the characteristics of individual middle ears. Building on the work of Keefe (Assoc. Res. Otolaryngol. Abs., 2001), we describe a promising method for using distortion-product otoacoustic emissions (DPOAEs) to measure the frequency dependence of forward and reverse middle-ear transmission noninvasively. As with the procedure outlined by Keefe, the method depends on the scaling properties of DPOAE generation in the cochlea (Shera and Guinan, 1999, J. Acoust. Soc. Am. 105:782). We discuss experimental tests of the method's assumptions and validate the method in the scaling region using simulated middle-ear transfer functions and a simple model for DPOAE generation. We compare our method with that of Keefe and use model results to explore the systematic errors inherent in his procedure. Finally, we discuss extensions to the method—including the use of DPOAE unmixing (Kalluri and Shera, 2001, J. Acoust. Soc. Am. 109:622) to mitigate the effects of DPOAE microstructure—necessary for applying the method in individual subjects.

770 Level-dependence of optimal stimulus-level difference for evoking DPOAEs in the gerbil

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Distortion product otoacoustic emissions (DPOAE) are produced by nonlinear mechanical amplification in the cochlea and strongly depend on functioning outer hair cells. To maximize DPOAE levels and hence to increase the sensitivity of DPOAE measurements, the level separation of the two primary stimuli has been shown to play a crucial role. In contrast to the conventionally used paradigm L1 = L2 + 10 dB, Kummer et al. (2000) found a variable level separation L1-L2 to be optimal for evoking maximal DPOAE levels in humans. They described this optimal level separation by the equation L1= 0.4L2 + 39 dB and used it to record threshold curves of mechanical auditory sensitivity. To obtain an adequate animal model for determination of auditory sensitivity and its pathologies our aim was to measure corresponding optimum level differences in the gerbil Meriones unguiculatus.

DPOAEs were recorded at two different test frequencies f2 = 3 and 10 kHz and three different frequency ratios f2/f1 for each f2-frequency. Both stimulus levels L1 and L2 were varied from 15 up to 70 dB SPL in 5 dB steps resulting in 144 L1 x L2 level combinations.

The results showed that, as in humans, a variable level separation L1-L2 is optimal for generating maximal DPOAEs in the gerbil. With decreasing L2 the optimal level separation increased up to maximal 19.5 dB at L2= 15 dB SPL. The corresponding equations differed significantly between the tested frequency ratios (1.2, 1.28, 1.36) and between the tested f2 frequencies and ranged between L1opt= 0.5 to 0.78L2 + 12.3 to 26.7 dB. This indicates that in the gerbil the corresponding DPOAE growth functions are slightly steeper than in humans. Despite such smaller quantitative differences the gerbil proves to be a good animal model for DPOAE measurements using the new stimulus paradigm as employed in clinical research.

This study was supported by the DFG, KO-987/6-3.